Intel Research and the Data Center of the Future

An Overview

Today's data center is the back office that runs the corporate IT infrastructure for a corporation. But changes are underway that are rapidly bringing the data center to the forefront of the enterprise. Wireless devices, such as notebook PCs and PDAs, are making it easier to connect all employees to the data center. At the same time, technologies like radio frequency identification (RFID) and wireless sensor networks promise to connect all factories, operations, products and processes to the data center. Wal-Mart*, for instance, has ordered its 100 top suppliers to have RFID tags on all products by 2005. Changes like these are going to dramatically increase the need for more processing, storage and manageability. All this points to one thing: the data center is becoming the hub of the real-time enterprise and a key strategic advantage for any business.

To deliver the "data center of the future," we as an industry need to develop new technologies for handling the enormous performance and storage demands of tomorrow while at the same time solving many of the other issues data centers face today. Years of adding more storage and more performance have resulted in the typical data center being saddled with a mix of proprietary servers, incompatible storage area network (SAN) implementations, separate management software for each device and serious security concerns. All this contributes to a high total cost of ownership (TCO). It takes too big of an IT staff to manage it all.

Intel research and development recognizes that the data centers of today face serious issues in preparing for the demands of tomorrow. Consequently, we focus on ways to make the data centers of the future high-quality, high-performance environments that reduce TCO, increase security, and deliver the huge gains in performance necessary to handle the 7.7 million terabytes per day Wal-Mart would need to process if all items in its U.S. retail stores had RFID tags[1].

The impact of many of the solutions you'll read about here remains five to seven years out.

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Delivering on the Data Center of the Future

Intel's Communications Technology Lab concentrates on ways to provide a compelling, innovative platform foundation for the data center of the future. We conduct extensive research on innovations to the data center infrastructure that address TCO increases, security lapses, and increasing demands for applications throughput.

We take a cross-platform, systems approach, conducting research in many different areas. These major focus areas include:

- **Server Network Acceleration** – Innovative processing techniques to improve overall server application throughput with lower network I/O overhead.
- **Intelligent Storage** – New storage architecture based on objects that provides low-cost, scalable storage with better manageability.
- **Self-Managed Platforms** – Building increased intelligence in distributed devices to provide increased intrusion detection and better systems management.

Addressing IT Top Priorities

Participating in many industry forums, Intel has identified three major problems as IT top priorities. These issues must be addressed for future data centers to be more cost effective, efficient and secure than current data centers.

1. Controlling Costs Through Lower TCO

According to the 2003 Worldwide IT Benchmark Report (META Group Inc.), the number one IT priority is reducing costs. Despite the best efforts of IT managers and CIOs, enterprise data center complexity and operational cost have continued to soar. Compounding the problem is the fact that even the most routine IT tasks require human intervention. Giga Information Group estimates that labor represents 46 percent of IT budgets and Gartner Dataquest notes that 40 percent of today's major service disruptions are caused by the operators themselves ("Addressing IT Challenges with Self-Healing Technology," Technology@Intel Magazine). Obviously, general operational expenses are one of the largest contributions to TCO. And these will have to be cut. According to a 2003 Gartner Group report, Winning Asset Management Strategy, Between 2004 and 2006, IS organizations will face intense pressure to reduce operational costs and keep spending in line with other shared enterprise services (such as finance and marketing).

2. Security

As the recent flurry of headline-grabbing viruses demonstrates all too clearly, protecting networks from today's fast-moving, blended threats is a more daunting task than ever. Despite plenty of warning and free security updates

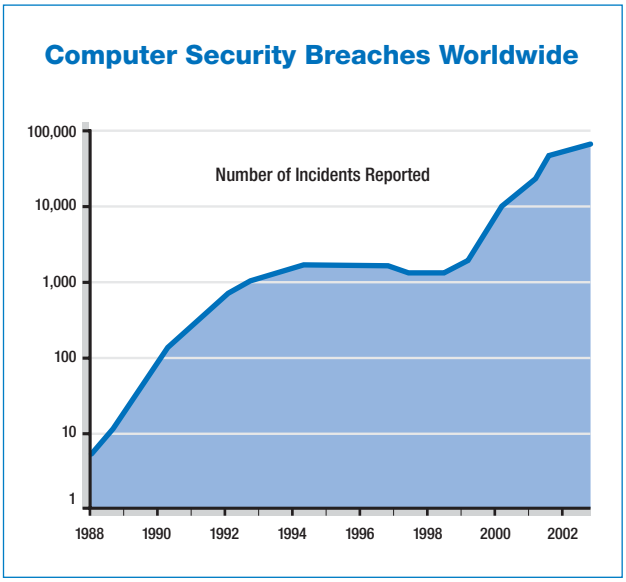

Figure 1. Computer Security Breaches Worldwide
(Source: Computer Security Emergency Response Team)

the W32.Blaster.Worm (a.k.a. Lovesan) still caused hundreds of millions of dollars worth of damage and infected as many as one million computers ("Blaster Worm Racks Up Victims," PC World, 8/15/03). The Sobig virus was much worse. Accounting for $29.7 billion of economic damages worldwide, the most ever for a virus ("Virus Damage Worst on Record for August," Internetnews.com, 9/2/03). In countries around the world, Sobig clogged corporate networks, slowed network access to a crawl, and forced e-mail systems temporarily offline to stop the attack. Obviously, the jump in IT security investment following September 11 remains hard to step back from as new threats continue to arise.

3. Application Throughput

Increasing Web services, the adoption of sensor networks and RFID, and greater use of IP storage to meet regulatory requirements will generate an overwhelming challenge for packet processing in the data center. For IT, this is the latest bottleneck needing a solution. Without fundamental architecture changes, packet volumes and bandwidth rates are on the verge of overwhelming the 20-year-old process used to create, inspect and receive packets. Why? Because with each 10 times increase in network bandwidth, CPUs must act on each arriving packet in one-tenth the time. Yet they can't. The number of CPU cycles required to get data from a packet on the wire and into application memory has remained relatively flat since the inception of Ethernet.* Consequently, increasing packet volume and rate directly increase CPU overhead and reduce the available CPU cycles for user applications, throttling server application throughput and degrading data center performance. The situation is only going to get worse.

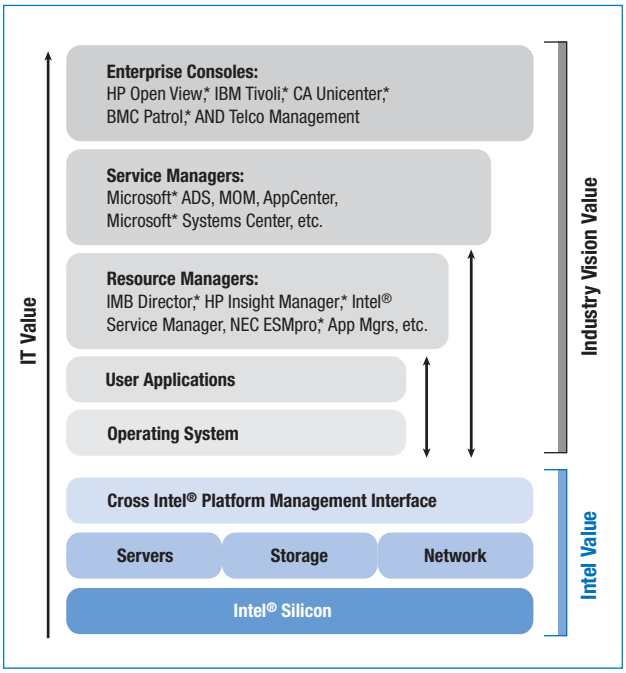

Figure 2. Intel's Added Value "Near the Silicon"

Taking a Different Approach by Getting "Near the Silicon"

A number of leading computer industry companies have announced multi-year initiatives that range from server virtualization to intelligent systems provisioning. These initiatives (such as Autonomic Computing, Utility Data Center, and Organic IT) are directly targeted to such IT primary concerns as lowering TCO (particularly through reducing management complexity) and improving security.

Although these initiatives have a lot of functionality in common, they also have another common trait – they're all software-based. Most are not standards-based, nor interoperable, and rely on a functioning operating system.

Intel's research takes a different approach aimed at "Near the Silicon" innovation. Our solutions are hardware-based – in processor or chipset silicon, in firmware or hardware platforms. Since these solutions are "Near the Silicon," they have a clear advantage. They operate below the operating system layer and are thus tamper-resistant.

Current Data Center Research Projects

With the exception of intelligent storage, the impact of our research into the following areas is generally five to seven years out.

Server Network Acceleration

The focus of our work in Server Network Acceleration centers is on improving server application throughput by more efficiently processing network packets. By improving server performance at higher network bandwidths, Server Network Acceleration provides greater headroom to meet peak compute demands. That means IT gets improved application throughput from each server processor, thus lowering their TCO. (For more detail, see separate paper entitled "Server Network Acceleration.")

Intelligent Storage

Our Intelligent Storage research involves object-based storage – exploring usage models of moving intelligence closer to storage devices. This improves performance by enabling self-management storage that can locally optimize data access and perform data integrity checking. What's more, access to storage data can be controlled at the device level, enhancing security. Object-based storage architectures also lend themselves to scale better at lower cost. (For more detail, see separate paper entitled "Object-based Storage.")

Self-Managed Platforms

Our work in Self-Managed Platforms focuses on a cross-platform management architecture enabling IT Managers to always have control of all data center equipment. They need visibility into system status, despite network anomalies that might cause operating system failures. Systems based on this platform will have the ability to manage themselves, including the ability to self-heal. This increases data center manageability and improves data center security. (For more detail, see separate paper entitled "Self-Managed Platforms.")

Systems Approach

Intel's research into Server Network Acceleration, Intelligent Storage and Self-Managed Platforms is part of a larger corporate charter to develop advanced cross-platform data center solutions based on a total systems approach. The inter-relationships these technologies have on one another demand such an approach. Server network acceleration affects how quickly network traffic can be handled, affecting throughput between storage devices and the network edge. Intelligent storage, based on objects, minimizes network traffic while providing data-level security not available elsewhere. Equally important, it provides scalable storage at low cost to address the exponentially growing data storage requirements expected in the data center of the future. Self-Managed Platforms play a pivotal role maintaining network security, ensuring distributed denial of service attacks or unexpected e-mail volume doesn't flood the network with traffic, impacting server/storage application throughput.

Using systems approach, Intel plans to deliver building blocks that leading vendors will use to develop solutions for enterprise IT customers. Our goal is to provide advanced technology that supports the successful data center of the future.

For More Information

Intel® Corporate Technology Group:
www.intel.com/labs/index.htm

Intel® Communications Technology Lab:
www.intel.com/labs/commnet

Papers and Articles

- Server Network Acceleration White Paper
- Intelligent Storage White Paper
- Self-Managed Platforms White Paper

1. This estimate was provided by Jim Crawford, vice president of Retail Forward.

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